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Sur l'excitation a tramantism, le parasitismus et l'ecoulement gommeux chez les amygdales.

Arch. Neer. d. Sci. Nat. 11:184:199. 1906.

(On the response to injury, parasitism and on the flow of gum, in the peach family).

by

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Translated by

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February 1912.

'06 Beijerinck, M. W. and Rant, A. A.

Sur l'excitation a tramantism, le parasitismus et l'ecoulement gommeux chez les amygdalees. Arch. Neer. d. Sci. Nat. 11 : 184-199. 1906.

Coryneum beigerinckii (probably same as Clasterosporium amygdalearum) a parasite on the bark of the almond tree, causes an abundant flow of gum when inoculated into the bark.

But in the former researches on this subject, sufficient attention has not been paid to the relation which exists between the flow of gum and the excitation produced by wounds, not between that excitation and parasitism. Light has been thrown on this subject by the experiments which the author has carried on with A. A. Rant and a preliminary sketch of these given in this article.

In these experiments, peach and almond trees were used because they are very sensitive to wounds and easily re-act by an abundant flow of gum.

1. Lesions of the Cambium of the Young Green Branches.

When the young twigs of the peach were wounded to the cambium, drops of gum appeared on these in less than a week. The flow at the tip of the twig is weak, then for a zone of 1-2 decimeters it is greatest, below this it decreases and finally disappears completely. This region of greatest flow seems to be slightly below and not identical with the region of maximum longitudinal growth.

The explanation of this is that the flow is in relation to the growth of the cambial thickness, both the cambium and

procambium, and in the parts which are distant this growth is weak and since the other paranchymatous tissues are unable to transform themselves into gum, we have no gumming here.

Those portions of the branch which have already formed a cork layer do not exude gum usually when wounded in the cambium in summer. But this is not always the case, it depends on the season, so that we may conclude that the flow of gum depends on the physiological condition of the tissues.

Microscopical examination of the wounds shows that the gum comes from the canals just inside the cambium circle and anatomically then the gum corresponds to secondary sap wood, which has been arrested in its development and has become liquid while it was yet in the cambial or cellular state. The formation of ducts results from the fact that the medullary ray cells of the cambium are not so easily transformed into gum as the wood cells. The gummosis, however, may involve also the forming medullary rays and then there are formed flat gummiferous cavities or large elliptical canals.

The situation and extent of the canals depends on the nature of the wound. When it is a small wound the canals are in the immediate neighborhood of the wound, but when it extends to the pith the canals are on the whole perephery. The canals attain a length of 1-10 mm. and their extremeties occupy an ellipse of which the lower focus lies on the wound. Thus the traumatic excitation may be observed more above than below the wound, and it extends further longitudinally than laterally.

Summing up then we may say that the phenomenon depends on a pathologic transformation of the embryo woody tissue

caused by a traumatic excitation.

2. Lesions of the Cambium of More Mature Branches.

When branches of the trees are brought in during February and March and their bases put in the water in a warm chamber it will be noticed in about 5-10 days that all the branches cease to exude gum at the cut, but the gum flows from wounds which are made in the branches, especially when these are oblique or transverse.

Like wounds at the same time made in the open air do not flow, probably because the temperature is too low to make possible the biochemical process necessary to that phenomenon. On the other hand when these branches are wounded in the summer, they do not exude gum, either out of doors or when brought in. It will thus be seen that it depends upon the physiological state of the cambium in the spring time. But it is not thus when the wound is infected with Coryneum, which always excites an abundant flow of gum.

This is what is observed when one examines in February the cambial ring near a cut from which gum has been flowing: First, one notices that the cambium at that season consists of several layers of cells. The line of demarkation between the bark and the wood is not distinct. But that which is most interesting is the formation of gummiferous canals in the cambial cloak, in the neighborhood and even at considerable distance from the wound, composed of several (4-6) layers of cells, in the same manner as we have described for the young green branches. On account of the lack of differentiation it could not be definitely determined that the canals were in the sap wood and not in

the bark, but the author was of that opinion.

In the older branches also it was observed that the gummiferous tubes occupied an ellipse with the wound at the lower focus. One can easily understand this when he considers that the excitation is spread in the xylem with the ascending sap. Aderhold's observation that the infections of Coryneum of wounds made above a ring without bark gave more of a flow of gum than those below the ring may be explained by the fact that the descending sap carried the nourishment (which is also necessary to the fungus) above the ring, but not below it.

Then we arrive at the same conclusion in regard to the older branches as the younger ones; the flow of gum is due to the liquefaction of the embrionic sap wood, produced by traumatic excitation.

The fact that some cavities are found even in the older wood is not contrary to this statement since it is probable that the wood was in the embryonic state when the cavities were formed. The completely formed wood never liquefies.

Excitations produced by poisons or burning.

Although we do not know at present just what we should understand by traumatic excitation, yet it may be supposed that it has to do with a mecrobiotic influence of the dieing cells on the living cambium cells. One would expect then that a violent poison introduced into the cambium would act in an analogous way or perhaps even more energetically, since its influence would reach a larger number of cells. One would also suppose burning would cause the same result although more feebly.

The author used corrosive sublimate as a poison, and in summer obtained results in 4-7 days: the punctures made in the young branches of the peach, and infected with the poison gave more of a flow of gum than one would expect simply from the puncture. Since this poison is fatal to fungi and bacteria the possibility of the gum coming from bacteria, for example one of the gum producing bacteria, that is not culturable is entirely excluded, although some authors have supposed this to be the case. The great flow of gum caused by Coryneum is explained by the fact that it produces a violent poison which acts like the sublimate, and produces a traumatic excitation of long duration.

Old branches of the apricot, injured in July, easily healed up wit h the formation of a callus when untreated, but when treated with sublimate they gave an abundant flow of gum.

The wounds made by burning gave the same result, though less marked; which is easy to understand, since the sublimate penetrating slowly by defusion in the dieing cells destroys new cells for a long time, farther and farther away. In the case of the burnt places, however, which induced by focusing the rays of the sun with a lens, the area remains limited. It is evident that in the center of this area there are dead cells, surrounded by a zone of necrobiotic cells these last having this characteristic, that the protoplasm is dead, but the enzymes and other enzymatic substances still retain their activity. Clearly then the conclusion is inevitable that the influences of these necrobiotic substances on the living cells is the cause of the flow of gum.

These circumstances have lead us to believe that there is a certain analogy between the transformation of the embryonic

tissue into gum and the action of the catalylic enzyme called cytase by the physiologists, which is able to dissolve the entire cells, and not the idea of the botanists, by which they have in view the liquefactions of the cell walls only and for which the more specific name of cellulase, gelase and prectinase are more convenient.

The hypothesis expressed in 1886 that the enzymatic substance, causing the gum comes from the fungus Coryneum, is not in accord with the actual facts in that it may now be considered as demonstrated that the excitation action of the fungus rests in a poison and that it is the necrobiotic cells themselves that secrete the agent of the gum.

The hypothesis that the catalytic enzymes coming from the necrobiotic cells, is the cause of the gum, indirectly corroborated by the fact that in the higher plants a cytolytic body has been found, active in the formation of the tracheids and vessels in the cellular meristem and in the procambium. There, the transformation undoubtedly consists of a cytolysis, in which the longitudinal liquified walls of the elements alone remains intact, while the material produced by the cytolysis, consists at least partially, of a body of a gumming nature, which may be found in the vessels.

From this then we see that the traumatic excitation is nothing other than bringing into activity, a process which takes place normally, and in fact in the very place where that power is the most strongly developed (the secondary sap wood). The gum produced under natural conditions is usually reabsorbed, but even this is not always the case since it is often found

in the completely formed vessels.

The author makes the following resume of this theory of the flow of gum :

1. The normal plant produces cytolytic substances which contribute to the formation of vessels and tracheids.

2. This physiological gum, thus formed is usually reabsorbed, but in certain cases may be found as such in the cavities of the walls.

3. The flow of gum depends on the excessive activity of the analogous cytolytic substances, produced by the necrobiotic cells, (necrobiosis meaning the cellular function which remains after the death of the protoplasm, the enzymatic substances having kept their activity).

4. The poisons, as corrosive sublimate, or the poison produced by Coryneum, augment then indirectly the cytolysis in the cambium and in the sap wood.

Influence of Saprophytes on Traumatic Excitation and the Flow of Gum in the Young Green Branches. Parasitism.

In the experiments it was found that when the young branches were wounded in July, the flow of gum took place for only a short distance, but this zone differed greatly in the various branches.

This seems to be the explanation :

The flow of gum is the direct consequence of a necrobiotic process : all the causes which produce necrobiosis then will cause the flow of gum. But, if simple wounds are sufficient in certain cases to produce this effect, then other circumstnaces causing the death of the cells, should have the same

effect. For example, the bacteria which do not produce any specific poison ought when introduced into the tissue to cause the death of the neighboring cells by cutting off the oxygen supply, and thus increase the flow of gum. He introduced Dematium pullulans into wounds thus and found that the zone of wounds producing gummosis was farther extended from the apex of the twig, but here the older portions still retained their immunity which is entirely contrary to the effect produced by Coryneum. Also got the same results with Phyllosticta persicae but not with the bacteria isolated from the gum, but he is of the opinion that other bacteria could be found which would produce the result.

(Here the author makes a degression of two pages on the saprophytic flora of the higher plants).

As regards parasites he found besides Coryneum, which was particularly active, Monilia fructigena and a Cytospora, both of which produced the flow of gum.

The thing that is characteristic of the parasites is the great intensity of their poisoning influence. When infected with Coryneum, the whole twig perished and the flow of gum was confined to the zone of transition between the living and the dead tissue. The only anatomical differences he observed, however, was that the formation of the gummiferous canals was more extensive when infected with Coryneum than when the poison was used.